WAVETEK

OPERATOR'S MANUAL

# 4-1/2 Digit, True RMS Series Digital Multimeters

## Models HD140B & 4410B

Electronic Services - Los Angeles
M14222X

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# 4-1/2 Digit, True RMS Series Digital Multimeters

## Models HD140B & 4410B

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# Section I Introduction

Model 4410B and Model HD140B are completely portable, 4-½ digit multimeters with liquid crystal displays (LCDs); designed to be accurate, reliable and always ready for use. Equipped with five functions and 27 ranges, each test position on the multimeter is easily selected with a simple turn of the selector switch. Small enough to fit in most attaché cases and equipped with a multiposition tilt stand, these multimeters are equally suited for design engineering, production testing, field servicing, and industrial maintenance applications.

Additionally, these multimeters offer three particularly useful digital multimeter features: Insta-Ohms® Quick Continuity Indicator, 10A AC/DC current measurement capability, and the capability of measuring both AC voltage and current in True RMS. True RMS permits accurate measurement of even the nonsinusoidal waveforms typically found in switching power supplies, motor speed controllers, SCR regulators, and digital systems.

## Standard Features

The multimeters include all of the following features as standard:

### Superior Reliability

To ensure reliability, Wavetek designed a custom CMOS large-scale integrated circuit to eliminate most components. All active multimeter functions are performed by this integrated circuit, reducing the number of parts in each instrument. Reliability is also enhanced by 100% burn-in of each multimeter and complete factory test of every function and range.

### Guaranteed Long-Term Accuracy

Specified accuracies are guaranteed for one (1) full year. Long-term accuracy is assured by an extremely stable, band-gap reference element and a high-precision, thin-film, voltage-divider network.

### Ruggedness

The Model 4410B is designed to give years of trouble-free operation under normal use. The heavy duty Model HD140B is designed to take accidental falls and still meet

specified accuracies. The liquid crystal display and single rotary switch are both recessed and sealed to prevent damage while in a tool box or on the job. The case has been designed to keep out dirt, dust, liquids, and other contaminants that can cause malfunctions in other multimeters.

**Waterproof (Model HD140B only)**

The meter has been completely sealed with O-rings around the case, the range selection knob, input terminal jacks, and the four screws that access the circuitry inside the unit. The display window is gasketed and ultrasonically sealed in the case for a waterproof seal.

**Overload and Transient Protection**

All inputs are protected against *continuous* overload conditions that may result from the measurement of unknown signals or from operator error, up to the limits of each function's stated input protection (see Specifications). In addition, all voltages and resistance ranges are protected against voltage transients up to 6kV, 10µs duration.

**Current Ranges**

*4410B*

The 2A input jack is protected by a 600V, 2A fuse. The 10A input jack is designed to withstand up to 20A for up to 30 seconds.

*HD140B*

The 2A and 10A input jacks are protected by a 600V, 15A fuse.

**Ease of Use**

Human engineered in every way to make the instrument easy to use, a single switch turns on power and selects both function and the desired range. The liquid crystal display (LCD) is easy to read both indoors and outdoors, even in direct sunlight.

**Diode Test**

Accurate measurements can be made of forward voltage drops across diodes and transistor junctions.

**Low Battery Indicator**

The symbol "BT" appears in the display when the battery has approximately 10 hours of operational life remaining.

### Versatility

Small, lightweight, and completely portable, the multimeter has a handy tilt stand for easy positioning and antiskid pads to keep it in place. Perfect for field, lab, or home use.

### Complete and Ready to Use

Multimeters are shipped with battery and fuse installed and are ready to use. Also included with each multimeter is a spare 2A fuse, TL245 Test Lead Set, and a complete operator's manual.

**Note**

The symbol on the front panel of the multimeter is an international symbol meaning "REFER TO OPERATING INSTRUCTIONS." Warnings and precautions to avoid personal injury and multimeter damage are listed in Section II.

**WARNING!**

**High voltages can be lethal. Use extreme caution when working with and measuring high-voltage sources. High voltage transients may occur in nearly all defective electronic equipment.**

**This manual contains important safety information and warnings which must be followed in order to ensure safe operation and to protect the user from serious injury or death.**

## Section II Safety Information

This section of the manual describes the various operating modes on the Multimeters as well as a summary of warnings and precautions.

### WARNINGS!

**When "W" is used in this manual it advises the user of a hazard that could result in serious injury or even death. The "W" refers the user to the "WARNINGS" below and in the operating instructions in Section IV.**

### PRECAUTIONS!

**When "P" is used in this manual it advises the user of a hazard that could cause damage or malfunction in the instrument. The "P" refers the user to the "PRECAUTIONS" below and in the operating instructions in Section IV.**

**"W" "P" WARNINGS & PRECAUTIONS**

1. **Do not attempt to measure voltage or currents that may exceed the ratings marked on the Function/Range Switch or terminal overlays.**
2. **Use extreme caution when working near high voltage sources. This includes any voltage measurements requiring the use of the two highest VAC or VDC ranges.**
3. **To avoid electrical shock hazard and/or damage to the multimeter, do not measure voltages that might exceed the maximum voltage rating above earth ground.**
4. **Operator injury or damage to the multimeter may occur during current measurements if the fuse blows in a circuit which exhibits an open circuit voltage greater than 600 volts.**
5. **Before each use of the multimeter, inspect test leads, connectors, and probes for cracks or breaks in the insulation. If any defects are found, replace item immediately.**
6. **To avoid electrical shock hazard, do not touch test leads, tips, or the circuit being tested while power is applied to the circuit being measured.**

"P" PRECAUTIONS

**Exceeding the maximum input overload limits can damage the multimeter.**

**When measuring current, check that the multimeter is connected in series with the load in which the current is to be measured. NEVER connect the multimeter ACROSS a voltage source. To do so can result in either blowing the overload protection fuse or damaging the device being tested.**

## Overload Indication

"P" PRECAUTIONS

**Range overload is indicated by "1" in display. This is normal in the OHMS range when the leads are not connected to anything. In all other situations, the user must take immediate steps to remove the cause of the overload condition from the instrument.**

The Models 4410B and HD140B Multimeters are equipped with automatic overload indication. This means that whenever an input signal is larger than the range selected, an OVERLOAD symbol ("1") will appear at the far left of the Digital Display, see Figure 7, p. 22. This feature allows the user to test devices with unknown circuitry where an overload condition might exist but would not exceed the capability of the multimeter.

## Voltage Measurements

"W" CRT SERVICE SAFETY REMINDER: A POTENTIAL DANGER
"P" TO YOU AND YOUR METER EXISTS WHEN MEASURING VOLTAGES IN THE HORIZONTAL OUTPUT AND DAMPER STAGES OF CRT EQUIPMENT. THIS DANGER IS CAUSED BY THE HIGH VOLTAGE TRANSIENTS (GREATER THAN 6,000 VOLTS) THAT OCCUR IN THESE CIRCUITS. PLEASE REFER TO YOUR CRT SERVICE MANUAL FOR PROPER SERVICING INSTRUCTIONS.

# Section III Preparation for Use

This section contains paragraphs that describe the following: unpacking and inspection, installation, controls, indicators, connectors, and initial checkout procedure.

## Unpacking and Inspection

Remove the multimeter from the shipping container. The box should contain the following items:

1. Multimeter
2. TL245 Probe Set (one black, one red)
3. Operator's manual
4. Nine-volt battery (installed)
5. Two 2 A fuses (one installed and one spare inside the case and one 15A fuse installed, HD140B only). To gain access to inside of multimeter, see Section VII.

Account for and inspect all of the above items. If any of the items are damaged or are missing, immediately return the complete package to the place of purchase for an exchange.

**Note**

Retain the shipping container for use if the multimeter must be returned for exchange or repair.

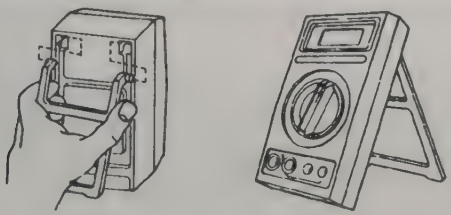


*Figure 1A. Position the Tilt Stand*

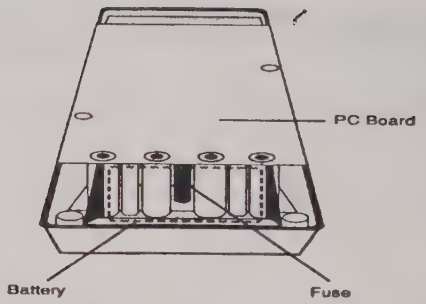



*Figure 1B. Position the Tilt Stand*

## Installation

The multimeter is shipped ready for use. The only action required by the user is to place the tilt stand in the desired position. Figure 1A and 1B show the two alternative positions of the tilt stand. The tilt stand is moved from one position to another by squeezing the two sides of the stand together and then reinserting the tips in the desired position.

## Multimeter Familiarization

WE STRONGLY RECOMMEND that the user become familiar with the controls, indicators, and connectors shown and described in Figure 2 before operating the multimeter.

1. **Digital Display**
   A 4½-digit display (maximum reading 19999) with automatic decimal point placement, automatic polarity indication, over-range indication, low battery indication, and the Insta-Ohms Quick Continuity Indicator (Ω) indicates measured input value in volts, amperes, or ohms as selected by the Function/ Range Switch. The LCD in the HD140B is shock mounted.

2. **Function/Range Switch**
   This switch turns the multimeter off and on and selects the function and range. Six functions can be selected by directing the pointer on the center bar to: VDC, VAC, DCA, ACA, Ω (ohms), and Diode Test. The VDC function provides five ranges from 200mV to 1500VDC. The VAC function provides five ranges from 200mV to 1000VRMS AC. The DCA and ACA functions each provide six ranges of current measurements from 200μA to 10A full-scale. The 20m/10A positions in the DCA and ACA functions serve two purposes. When a test lead is plugged into the "A" input jack, the 20m/10A position serves as the 20mA range. When a test lead is plugged into the "10A" input jack, the 20m/10A position serves as the 10A range. The Ω function provides five ranges of resistance measurements from 2000Ω to 20MΩ. The continuity test function operates in any resistance range.
3. **Diode Test Function**
   Used for checking diodes and other semiconductor junctions.
4. **10A Input Connector**
   Banana jack connector used for continuous current measurements up to 10A. Inputs beyond this maximum may cause damage to the multimeter. The HD140B multimeter is protected by a fuse against inputs over 10A.
5. **A Input Connector**
   Banana jack connector used for current measurements up to two amperes. The multimeter is protected by a fuse against inputs over two amperes with an open-circuit voltage of 600VDC or peak AC or less.
6. **COM Input Connector (black)**
   Banana jack connector used as the common or low input for all measurements.
7. **V-Ω Input Connector**
   Banana jack connector used as the high input for all voltage and resistance measurements.

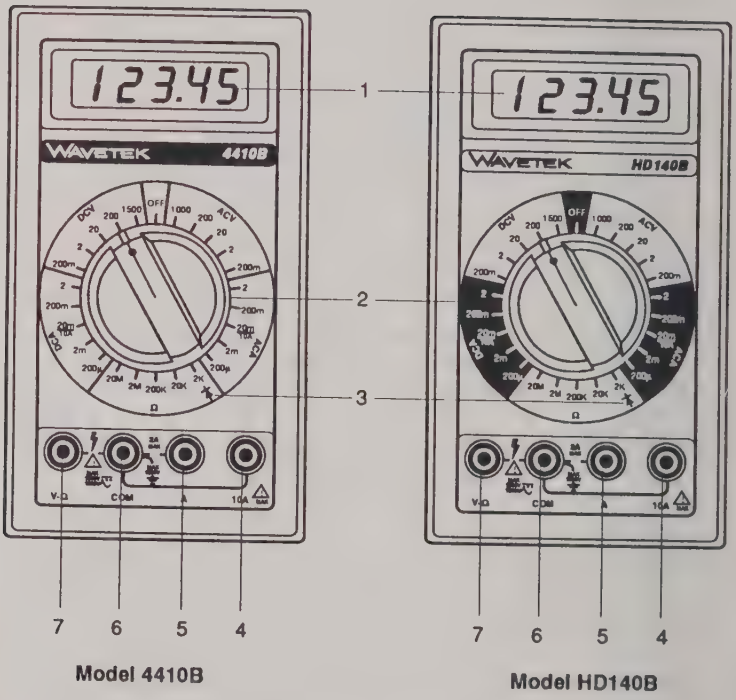



*Figure 2. Operating Controls, Indicators, and Connectors*

## Initial Checkout

Before placing the Multimeter into use, a simple checkout procedure will ensure that it is working properly. The only equipment required is the test leads.

1. Be certain that battery and fuse are installed properly, see Section VII.
2. Connect the red test lead to the V-Ω Input Connector and the black test lead to the COM Input Connector.
3. Place the Function/Range Switch in the 1500VDC position.
4. Touch the red and black test leads together. Check the Digital Display; it should read 000.0±2.
5. Turn the Function/Range Switch counterclockwise to each VDC position while observing the Digital Display. With the test lead tips in contact, the Digital Display should read zero plus or minus two digits and the decimal point positioned as follows:

| | |
|---|---|
| 200V | 00.00 |
| 20V | 0.000 |
| 2V | .0000 |
| 200mV | 00.00 |

6. Turn the Function/Range Switch to the 20MΩ position. With the two test lead tips separated, the Digital Display should read "1" (over-range).
7. Touch the test lead tips together and observe the Digital Display; it should read 0.000±.002.
8. Turn the Function/Range Switch to each ohm position while observing the Digital Display. With the test lead tips in contact, the Digital Display should read zero ±2 counts in each position.

| | | | |
|---|---|---|---|
| 20MΩ | 0.000 | 2MΩ | .0000 |
| 200kΩ | 00.00 | 2kΩ | .0000 |
| 20kΩ | 0.000 | | |

9. Turn the Function/Range Switch to the 1000VAC position.

**"W" The next step requires the measurement of the standard 120VAC household voltage. Be careful not to touch the test lead tips with fingers and do not allow the tips to contact each other.**

10. Measure the household voltage at a convenient AC power outlet.
11. Remove both probes from the AC outlet.

## Before Measurement

To insure that your Multimeter is operating properly, and the test leads are not damaged, perform this check before each operation of the meter, regardless of the type of measurement to be made.

With the red test lead in the V-Ω Input connector, and the black test lead in the COM connector, select the 2kΩ range and touch the test lead tips together. If the display reads .0000+2 counts, continue with your measurements. If the display reads a larger number or "1" (range overload), check first to see if the test leads are damaged or defective, and replace if necessary. If display still reads a high or open circuit value, the meter should be sent in for repair before further use.

## Voltage Measurements

**DC Voltage**

1. Connect red test lead to V-Ω Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired VDC position. If the magnitude of voltage is not known, set switch to highest range and reduce setting until satisfactory reading is obtained.
3. Turn off power to device or circuit being tested and discharge all capacitors.

**"W" To avoid electrical shock hazard and/or damage to the multimeter, do not attempt to measure voltages that might exceed the1500VDC or peak AC.**

4. Connect test leads to device or circuit being measured.
5. Turn on power to device or circuit being measured. Voltage value will appear on Digital Display along with the voltage polarity.
6. Turn off power to device or circuit being tested and discharge all capacitors before disconnecting test leads from device or circuit being tested.

**AC Voltage**

1. Connect red test lead to V-Ω Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired VAC position. If the magnitude of voltage is not known, set switch to highest range and reduce setting until satisfactory reading is obtained.
3. Turn off power to device or circuit being tested and discharge all capacitors.

> **"W" To avoid electrical shock hazard and/or damage to multimeter, do not attempt to measure voltage that might exceed 1000VRMS or 1500V peak.**

4. Connect test leads to device or circuit being measured.
5. Turn on power to device or circuit being measured. Voltage value will appear on Digital Display.
6. Turn off power to device or circuit being tested and discharge all capacitors before disconnecting test leads from device or circuit being tested.

**AC Conversion Process**

Understanding the AC conversion process in the multimeter will help the user to more fully utilize its measurement capability. The AC converter used in many digital multimeters is "average-responding." An RMS value is determined by first rectifying and filtering the signal to obtain the average value. The average value is then scaled upward by a factor of 1.11 to obtain the RMS value. The scaling factor of 1.11 is accurate in the average and RMS values is as follows:

$$VRMS = \frac{Vavg\ \pi}{2\sqrt{2}} = 1.11\ Vavg$$

In measuring nonsinusoidal waveforms, however, significant errors can be introduced because of different scaling factors relating average to RMS values. Rough correction factors can be sometimes calculated for standard waveforms that are free from significant noise and distortion but accurate measurements of complex waveforms can be difficult to achieve.

RMS values of nonsinusoidal signals can be measured directly and more accurately with the 4410B and HD140B which feature a "True RMS responding" converter. True

RMS response can be particularly useful in measuring complex or noisy signals for which even rough correction factors cannot be easily computed.

Converters of all types are limited by their frequency response and input dynamic range. Bandwidth defines the range of frequencies in which the conversion accuracy is within three decibels. The bandwidth of the 4410B and HD140B is 100kHz. Measurements of complex signals will not be affected by converter bandwidth limitations unless there are significant harmonic components beyond 100kHz.

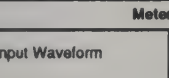
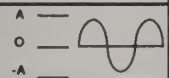
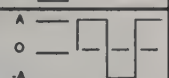
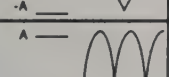
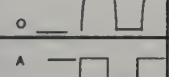
| Meter Display Reading | | | |
|---|---|---|---|
| Input Waveform | HD140B & 4410B AC True RMS | Avg Responding DMMs | True RMS (AC + DC) Total RMS = $\sqrt{AC^2 + DC^2}$ |
| Sine  | 0.707A<br>CF= 1.414 | 0.707A | 0.707A<br>CF = 1.414 |
| Square  | 1.000A<br>CF = 1.000 | 1.111A | 1.000A<br>CF = 1.000 |
| Triangle  | 0.577A<br>CF = 1.733 | 0.555A | 0.577A<br>CF = 1.733 |
| Full Wave Rectified Sine | 0.308A<br>CF = 3.247 | 0.298A | 0.707A<br>CF = 1.414 |
| Half Rectified Sine Wave  | 0.386A<br>CF = 2.591 | 0.389A | 0.500A<br>CF = 2.000 |
| 50% Duty Cycle Pulse Train $T_0 = T_1$ | 0.500A<br>CF = 2.000 | 0.555A | 0.707A<br>CF = 1.414 |
| Variable Duty Cycle Pulse Train $X = T_0/T_1$ $Y = \sqrt{X - X^2}$  | AY<br>$CF = \frac{A}{Y}$ | 1.111AY | $A\sqrt{X}$<br>$CF = \frac{1}{\sqrt{X}}$ |

*Figure 3. Typical Input Waveforms with Meter Display Reading and Crest Factors (CF)*

Crest factor is a measure of the input dynamic range of a True RMS responding converter. It expresses the capability of the converter to handle a signal that has large peak values compared to its RMS value without saturating the converter circuitry and degrading the specified accuracy.

For the 4410B and HD140B crest factor is defined as the ratio of the peak voltage to the RMS (AC coupled) voltage.

$$\text{Crest Factor} = \frac{\text{V peak}}{\text{VRMS}}$$

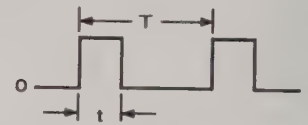
Crest Factor for an AC coupled pulse train is as follows:

$$\text{Crest Factor} = \frac{1\text{-}X}{Y}$$

Where

$$X = \frac{t}{T}$$

$$y = \sqrt{x\text{-}x^2}$$




Crest factor for the 4410B and HD140B ranges from 1.0 to 5.0 on each voltage scale depending on the RMS value of the signal being measured. At full-scale (1999 counts), signals with crest factor between 1.0 and 1.5 can be measured. Signals with crest factor of 1.0 include a square wave or pure DC (peak voltage equals RMS voltage). An undistorted sine wave signal (crest factor = 1.414) can also be measured at full-scale.

At half scale (1000 counts), signals with crest factor between 1.0 and 3.0 can be measured without performance degradation. At 600 counts and below, signals with crest factors up to 5.0 can be measured. If the crest factor of a waveform is not known, it can be determined by measuring the peak voltage with an oscilloscope and dividing by the RMS voltage measured by the multimeter. The crest factors and corresponding display readings for some typical waveforms are shown in Figure 3, page 15.

## Total RMS Measurements

The 4410B and HD 140B permits measurement of the True-RMS value of the AC component of a signal. Sometimes, it is useful to be able to find this value of the AC and the DC components of the signal (such as measuring the power outputs of switching power supplies). To accomplish this:

1. Set the 4110B and the HD140B to the right VDC range, measure the DC component and record the result;
2. Set the 4110B and the HD140B to the right VAC range, measure the AC RMS component, record the result;
3. Figure the True-RMS value by the following formula:

   $$\text{True-RMS} = \sqrt{(\text{AC RMS Component})^2 + (\text{DC Component})^2}$$

## Current Measurements

**DC Current**

1. For current measurements up to 2A connect the red test lead to the A Input Connector. For current measurements between 2A and 10A, connect the red test lead to the 10A Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired DCA position. If the magnitude of current is not known, set switch to highest range and reduce setting until satisfactory reading is obtained. When the 10A Input Connector is used, the Function/Range Switch should be in the 20m/10A position.
3. Turn off power to device or circuit being tested and discharge all capacitors.
4. Open circuit in which current is to be measured. Securely connect test leads in series with the load in which current is to be measured.
5. Turn on power to circuit being tested.
6. Read current value on Digital Display.
7. Turn off all power to circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

**AC Current**

1. For current measurements up to 2A, connect red test lead to the A input Connector. For current measurements between 2A and 10A, connect red test lead to the 10A Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired ACA position. If the magnitude of current is not known, set switch to highest range and reduce setting until satisfactory reading is obtained. When 10A Input Connector is used, the Function/Range Switch should be placed in the 20m/10A position.
3. Turn off power to device or circuit being tested and discharge all capacitors.
4. Open circuit in which current is to be measured. Securely connect test leads in series with the load in which the current is to be measured.
5. Turn on power to circuit being tested.
6. Read current value on Digital Display.
7. Turn off all power to circuit being tested and discharge all capacitors.
8. Disconnect test leads from circuit and reconnect circuit that was being tested.

**Resistance Measurements**

1. Connect red test lead to V-Ω Input Connector. Connect black test lead to COM Input Connector.
2. Set Function/Range Switch to desired ohm position. If the magnitude of resistance is not known, set switch to highest range and reduce setting until satisfactory reading is obtained.
3. If the resistance being measured is connected to a circuit, turn off power to circuit being tested and discharge all capacitors.
4. Connect test leads to circuit being measured. When measuring high resistance be careful not to contact adjacent points, even if insulated. Some insulators have a relatively low insulation resistance, which can affect the resulting measurement.
5. Read resistance value on Digital Display. If a high resistance value is shunted by a large value of capacitance, allow the Digital Display to stabilize.

# Diode and Transistor Tests

Diodes and Transistors can easily be tested using the 2kΩ range of the resistance function of the 4410B and the HD140B. When this function is selected a constant current of the 1mA is supplied to the V-Ω input jack which can be passed through the semiconductor junction being tested and sensed by the input jack of the meter. The forward voltage drop across the junction can then be read from the digital display.

**Diode Test (forward bias voltage)**

1. Connect the red test lead to the V-Ω input jack and the black test lead to the COM input jack.
2. Set the Function/Range Switch to the Diode Test (⊣◀⊢) position (the 2k range of the resistance function).
3 The semiconductor junction being measured must be removed from the circuit.
4. Connect the test probes as shown in Figure 4.

***Figure 4. Diode Hookup***

5. Read the forward voltage drop on the digital display. Readings are in volts. Ignore the "Ω" symbol on the display.

   If a "1" appears at the far left of the digital display (overload indication), reverse the lead connections. A normal forward bias voltage for a silicone semiconductor junction should be 600mV to 900mV.

   If the digital display indicates overload while the leads are correctly connected, the junction is open.

   If a reading of less than 1V is present with the leads reversed, the junction is shorted.

### Transistor Junction Tests

Transistors can be tested in the same manner as diodes by checking the two diode junctions formed between the base and emitter and the base and collector of the transistor (see Figure 5). Measurements between the collector and emitter should also be made to determine if a short circuit is present.

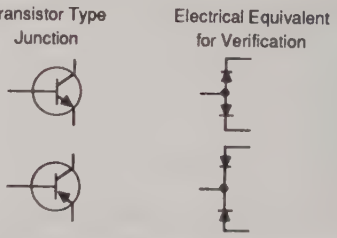



*Figure 5. Orientation of Effective Diode Junctions for PNP and NPN Transistors*

### Transistor Beta Test

With the simple test fixture provided by the user, the resistance function, set to the 2k range, can be used to determine the DC current gain (beta) of a transistor. Beta is measured using DC collector-to-emitter (VCE) voltage of about 1V at a collector-current of about 1mA.

The transistor beta test setup is shown in Figure 6 for an NPN transistor. For PNP transistors, the connections to the multimeter should be reversed.

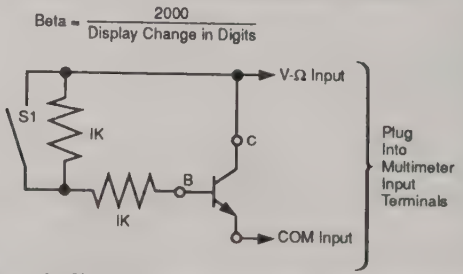



*Figure 6. Test Fixture for Transistor Beta Measurement*

To determine transistor beta, use the following procedure:

1. With all the connections as shown in Figure 6, and with S1 open, record the displayed reading.

> **Note**
>
> If an overload indication is obtained, reverse the connections to the multimeter.
>
> If an overload indication is obtained regardless of meter orientation, the transistor is probably defective.

2. Close S1 and record the new displayed reading.

3. Divide 2000 by the difference of the readings, in digits, taken in Steps 1 and 2. The resulting number is the DC beta of the transistor.

## Continuity and Capacitor Checks

The Wavetek Insta-Ohms Quick Continuity Indicator allows continuity checks to be done just as quickly and as easily as with an analog meter. This feature is particularly useful in circuit and cable tracing, but also may be used for troubleshooting small-value capacitors.

### Continuity Checks

1. Place Function/Range Switch in any ohm range.
2. Connect red test lead to the V-Ω Input Connector. Connect the black test lead to the COM Input Connector. With the test leads separated or measuring an out-of-range resistance, the Digital Display will indicate "1" (overload), Figure 7.
3. Place one test lead probe at one end of cable or circuit to be tested. Use the other test lead to trace the circuit or cable until the circuit is complete. When continuity is established, an ohm symbol will appear in the left-hand portion of the Digital Display, Figure 8. If contact in the cable or circuit is maintained long enough (about one-quarter of a second) and the resistance value being measured is less than the maximum for the range selected, the "1" will disappear and the resistance value of the cable or circuit will appear next to the ohm (Ω) symbol, Figure 9.

*Figure 7. Display of Overload Symbol*

*Figure 8. Display of Insta-Ohms Quick Continuity Indicator (Ω)*

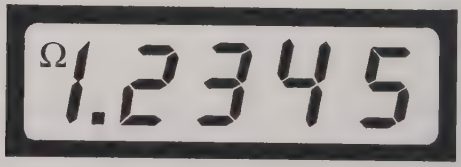



*Figure 9. Display of the Insta-Ohms Quick Continuity Indicator (Ω) and Resistance Value*

**Note**

The Inst-Ohms Quick Continuity Indicator quickly identifies completed circuit paths.

**Capacitor Checks**

The Insta-Ohms Quick Continuity Indicator also can be used as a rough check of capacitors with a value of greater than or equal to 0.05μF. This feature can be a great aid in troubleshooting circuits in which an open or shorted bypass capacitor is suspected. Use the following procedure to check capacitors.

1. Place Function/Range Switch in 20MΩ range position.
2. Connect red test lead to V-Ω Input Connector and black test lead to the COM Input Connector. With test leads separated, the digital display indicates "1" (overload, Figure 7).
3. Discharge the capacitor to be checked by briefly shorting the capacitor ends.
4. Place red test lead probe at one end of capacitor. Place the black test lead at other end of capacitor.

**Note**

Do not touch capacitor leads or test probe ends during capacitor check because proper operation of Insta-Ohms feature could be affected.

5. If the Insta-Ohms symbol (Ω) appears and then disappears, the capacitor is accepting a charge.

   *Mylar Capacitors*

   If the Insta-Ohms symbol does not appear, the capacitor is probably open. If a low resistance value appears, the capacitor is probably shorted or leaking.

   *Electrolyte and Tantalum Capacitors*

   A good capacitor will show a resistance reading that rises steadily from 0.00Ω to infinity (overload symbol appears). This reading could stabilize at a very high value (MΩ), depending on the size and quality of the capacitor. If the reading stabilizes at a low value, the capacitor is probably bad.

**Note**

Insta-Ohms can only be used to check capacitors with a value of 0.01μF or greater.

## Decibel Measurements

In addition to its normal functions, the multimeter can be used to measure decibels. The value obtained from this measurement can be used to indicate the gain and accuracy of electronic devices. The decibel (dB) is the logarithm of the ratio of two electrical signals; usually a certain amount of power dissipated in a fixed resistance is used as a reference and denoted as 0 (zero) decibels. In Figure 10, zero decibel is defined a 1mW into 600Ω. Use the procedure on page 13 to determine AC voltage and the graph of Figure 9 to determine decibel value.

*Figure 10. Decibel Conversion Chart*

# Section V Specifications

Specifications are subject to change without notice.

## General Specifications

The following specifications apply to the Models 4410B and HD140B Digital Multimeters:

| | |
|---|---|
| **Operating Temperature Range** | 0°C to +50°C |
| **Storage Temperature Range** | -40°C to +65°C with battery removed |
| **Display** | 4-½-digit and liquid crystal display (LCD) with a maximum reading of 19999 |
| **Power** | Single, standard 9V battery, NEDA 1604 |
| **Battery Life** | Zinc-Carbon: 100 continuous hours, nominal |
| **Low Battery Indicator** | Symbol "BT" appears in digital display with 10 hours battery life remaining |
| **Shock and Vibration** | Meets MIL-T-28800 Class II Type A specifications |
| **Relative Humidity** | 0% to 80%, 0°C to 35°C; 0% to 70%, 35°C to 50°C |
| **Temperature Coefficient** | (0°C to 18°C, 28°C to 50°C) <10% of applicable accuracy specification per °C |
| **Dimensions** | 6.90 inches (17.4 cm) long x 3.70 inches (9.3 cm) wide x 1.87 inches (4.6 cm) high |
| **Annunciator Symbols** | "-," Negative Sign; Positive Sign is implied<br>"Ω," Continuity is detected (Insta-Ohms)<br>"BT," Low Battery<br>"1" at far left of display, input is exceeding selected range |
| **Weight** | 18 oz. (499gr.) including battery |
| **Calibration** | Accuracy specifications guaranteed for one (1) year, 23°C ±5°C |

| | |
|---|---|
| **Measurement Rate** | Two measurements per second, nominal |
| **Case** | High-impact ABS plastic, fire retardant |
| **Multimeter Includes:** | 1. 9V battery<br>2. Spare 2A fuse<br>3. TL245 Probe Set<br>4. Operator's manual |

**DC Volts**

The following specifications apply to the Models 4410B and HD140B unless otherwise indicated:

| RANGE | RESOLUTION | ACCURACY (23°C + 5°C) |
|---|---|---|
| ± 200mV | 10µV | .05% ± 2 digits |
| ± 2V | 100µV | .06% ± 2 digits |
| ± 20V | 1mV | |
| ± 200V | 10mV | .07% ± 2 digits |
| ± 1500V | 100mV | |

| | |
|---|---|
| **Input Impedance** (all ranges) | 10MΩ |
| **Normal Mode Rejection Ratio** | >60dB, 45Hz to 1kHz |
| **Common Mode Rejection Ratio** | >140dB to 1500VDC |
| (1kΩ unbalance) | >120dB, 45Hz to 400Hz, to 1000VAC |
| **Measurement Response Time** | <1 sec. |
| **Overvoltage Protection** | 1500VDC or peak AC on 2V–1500V ranges<br>1000VDC or peak AC on 200mV range |
| **Transient Protection** | 6kV for ≤10µs |

**AC Volts**

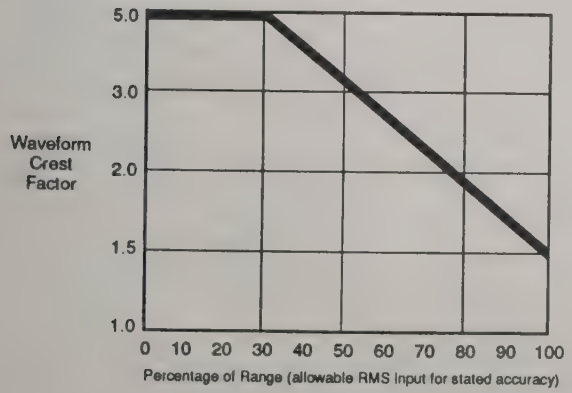
The following specifications apply to the Models 4410B and HD140B, unless otherwise indicated:

| | | ACCURACY, 10% - 100% of Range (+23°C ±5°C) | | |
|---|---|---|---|---|
| Range | Resolution | 45Hz to 2kHz | 2kHz to 5kHz | 5kHz to 10kHz |
| 200mV | 10µV | 0.5% ± 20 digits | | |
| 2V<br>20V<br>200V | 100µV<br>1mV<br>10mV | ±1.5%<br>±20 digits | ±1.5%<br>±30 digits | ±1.5%<br>±40 digits |
| 1000V | 100mV | 45Hz to 1kHz<br>±1.5%<br>±20 digits | | |

**Input Impedance** (all ranges) 10MΩ shunted <100pF

**True RMS** AC coupled

**Crest Factor** (peak/RMS ratio) Varies from 1 to 5 (see graph below)



**Measurement Response Time** <2 sec.

**Overvoltage Protection** 500VRMS or 400VDC on the 200mV range
1000VRMS (1500V peak) or 1500VDC
on 2V–1000V ranges

**Transient Protection** ≤6kV for 10μs

**DC Current**

The following specifications apply to the Models 4410B and HD140B unless otherwise indicated:

| Range | Resolution | Accuracy (23°C ±5°C) |
|---|---|---|
| ±200μA<br>±2mA | 10nA<br>100nA | 0.2% ±2 digits |
| ±20mA<br>±200mA | 1μA<br>10μA | 0.3% ±2 digits |
| ±2A<br>±10A | 100μA<br>1mA | 0.5% ±2 digits<br>1.0% ±2 digits |

**Voltage Burden**

200μA to 200mA: ≤250mV @ full-scale
2 A: ≤750mV @ full-scale
10A: ≤600m @ 10A

**Overcurrent Protection**

10A Input (4410B): 10A, continuous
20A for 30 sec. (unfused)

10A Input (IID140B): 15A, 600V (fused)
100MA energy interrupt
(Input is rated ≤20A for 30 sec.)

**Response Time** <1 sec.

**AC Current**

The following specifications apply to the Models 4410B and HD140B unless otherwise indicated:

| | | ACCURACY, 10% to 100% of Range +23°C ±5°C |
|---|---|---|
| Range | Resolution | 45Hz to 1kHz |
| 200µA<br>2mA | 10nA<br>100nA | 0.7%<br>±20 digits |
| 20 mA<br>200mA | 1µA<br>10µA | 0.8%<br>±20 digits |
| 2A | 100µA | 1.0%<br>±20 digits |
| 10A | 1 mA | ±1.5%<br>±20 digits |

**Voltage Burden**

200µA to 200mA: ≤250mV @ full-scale
2 amperes: ≤750mV @ full-scale
10 amperes: ≤600mV @ 10A

**Overcurrent Protection**

10A input (4410B): 10A continuous
20A for 30 sec. (unfused)
10A input (HD140B): 15A, 600V (fused)
(input is rated ≤20A for 30 sec.)

**True RMS** AC coupled

**Response Time** <2 sec.

**Resistance**

The following specifications apply to the Models 4410B and HD140B unless otherwise indicated:

| | | Test | Accuracy |
|---|---|---|---|
| Range | Resolution | Current ± 10% | 23°C ± 5°C |
| 2k | 0.1Ω | 1mA | |
| 20k | 1Ω | 100μA | ±0.1% |
| 200k | 10Ω | 10μA | ±2 digits |
| 2M | 100Ω | 1μA | |
| 20M | 1kΩ | 0.1μA | ±0.3% ±2 digits |

**Open-Circuit Voltage** ≤4V

**In-Range Voltage** ≤2 V

**Response Time** <1 sec. on 2k, 20k, and 200k ranges
<2 sec. on 2M and 20M ranges

**Overload Protection** 500VDC or RMS AC, any range (Model 4410B)
600VDC or RMS AC, any range (Model HD140B)

**Diode Test**

Diode test measurements are easily performed with the resistance function (see Section IV).

**Insta-Ohms® Quick Continuity Indicator**

**Response Time** <100ms

**Calibration**

To maintain the specifications described in Section VII of this operator's manual, we recommend that the multimeter be calibrated once each year and/or after it is repaired. For information regarding calibration procedures, please refer to the 4-½ Digit, True RMS Series Service Manual.

### Service Manual

A complete service manual (FG-3000-940-143) is available from Wavetek Corp., for those users who desire to service their own multimeters. To obtain a copy of this manual, send $15.00* (postage and handling) in the form of a check, money order, or a purchase order made payable to Wavetek Corp. See shipping address in Section VIII.

### Multimeter Storage

**"W" If multimeter is to be stored at temperatures above 122°F (50°C), remove battery.**

* Prices subject to change without notice.

## Accessory Descriptions

This section provides a description of the 4-½ Digit, True RMS Series Multimeter accessories that are available from Wavetek Corporation.

**Vinyl Carrying Case** (VC201)

The vinyl carrying case is constructed of durable, padded vinyl and will accommodate any 4-½ Digit, True RMS Series Multimeter Models. The case has room for the multimeter, operator's manual, and the TL245 Probe Set without adding any unnecessary bulk. The back of the case has a handy belt loop.

**Deluxe Carrying Case** (DC205)

Handsome, yet rugged, this case offers maximum protection for any 4-½ Digit, True RMS Series Multimeter and is designed to permit in-case operation. Constructed of rigid, leather-grained vinyl, the deluxe case has inside compartments for storing the multimeter, test lead set, and the operator's manual.

**Deluxe Carrying Case** (DC207)

Tough and attractive, this case offers maximum protection for any 4-/2 Digit, True RMS Series Multimeter and is designed to permit in-case operation. Constructed of rigid, leather-grained vinyl, the deluxe case has inside compartments for storing the instrument, test lead set, the operator's manual, and an extra compartment for a current clamp or small tools.

**High Voltage Probe** (HV231-10)

The HV231-10 High Voltage Probe extends the DC voltage measurement capability of any 4-½ Digit, True RMS Series Multimeter to 50kV. This accessory is essential for television and CRT terminal service where second anode voltages must be measured. This probe contains a precision 1000:1 resistor divider that scales high voltages down to a level that the multimeter can handle safely. The high input impedance of the probe minimizes circuit loading and assures accurate measurements.

*High Voltage Probe Specifications*

| | |
|---|---|
| Voltage Range: | 40kVDC or VAC peak ≤300Hz |
| Input Resistance: | 1000MΩ |
| Input Impedance Compatibility: | 10MΩ or less |
| Division Ratio: | 1000 :1 |
| Accuracy: | DC ±2%, AC ±3% |
| Temperature Coefficient: | <200ppm/°C |

*Operation with HV231-10 High Voltage Probe*

> **"W" The HV231-10 High Voltage Probe is used to measure potentially lethal voltages. Always disconnect power and discharge voltage source before connecting or disconnecting the High Voltage Probe.**

When the High Voltage Probe is used, the probe replaces the standard test leads. The probe is connected to the multimeter in the same manner as the TL245 Probe Set leads, and measurements are made as described in Section IV except that, because the probe is a precision 1000:1 divider, the Digital Display readings are in kilovolts. A measured value of 50kV will therefore read 50.0 with the Function/Range Switch in the 200VDC position.

**RF Probe** (RF241)

The peak detecting RF241 RF Probe extends the VAC measuring capability of the 4-1/2 Digit, True RMS Series Multimeters to 200MHz. It provides VDC calibrated to equal the RMS value of a sine wave.

*RF241 Probe Specifications*

| | |
|---|---|
| Frequency Range: | 2kHz to 200MHz |
| Accuracy: | ±(1% input + 50mV), from 2kHz to 10MHz<br>±1dB from 10MHz to 10MHz<br>±6dB from 100MHz to 200MHz |
| Maximum Reading: | 25VRMS |
| Response: | Peak sensing, RMS calibrated |
| Input Impedance: | 1.5MΩ in parallel with 7pF |
| Overvoltage Protection: | 130VRMS at 60Hz or 250VDC |

*Operation with RF241 Probe*

The RF241 RF Probe is connected to the meter like the TL245 Probe Set leads. Measurements are made as described in Section IV. Use appropriate VDC range from 200mV to 200V and read voltage signal directly in VRMS.

**AC Current Clamp** (CT231)

The CT231 AC Current Clamp extends the AC current measurement capability of any 4-½ Digit, True RMS Series Multimeter to 150A without breaking the circuit under test. The 1000:1 current transformer allows direct reading in amperes when used with the 200mA AC current range of the multimeter.

*CT231 Current Clamp Specifications*

| | |
|---|---|
| Range: | 10A to 150A RMS AC |
| Frequency Range: | 40Hz to 500Hz |
| Accuracy: | ±3% rdg. ±0.15A |
| Division Ratio: | 1000:1 |
| Circuit-to-Ground Voltage: | ≤660 VRMS |
| Maximum Conductor Size: | 0.45 inch (11.4 mm) |

*Operation with CT231 Current Clamp*

The CT231 AC Current Clamp is connected to the A and COM Input Connectors of the multimeter in place of the TL245 Probe Set leads. The jaws of the current clamp are placed around one of the current carrying conductors. In the 200mA ACA position, current is read directly in amperes.

**AC Current Clamp** (CT232)

The CT232 AC Current Clamp extends the AC current measurement capability of any 4-½ Digit, True RMS Series Series Multimeter to 1000A by use of a 1000:1 current transformer. The clamp-on design permits AC current measurements without breaking the circuit under test.

*CT232 AC Current Clamp Specifications*

| | |
|---|---|
| Range: | 10A to 1000A RMS AC |
| Frequency Range: | 40Hz to 10kHz |
| Accuracy: | ±1% rdg ±0.1A |
| Division Ratio: | 1000:1 |
| Circuit-to-Ground Voltage: | ≤660VRMS |
| Maximum Conductor Size: | 2.125 inches (54mm) |

*Operation with CT232 AC Current Clamp*

The CT232 AC Current Clamp is connected to the A and COM Input Connectors of the multimeter in place of the TL245 Probe Set leads. The jaws of the current clamp are placed around one of the current carrying conductors. With the multimeter in the 2A ACA position, the displayed value is multiplied by 1000 to obtain measured current in amperes.

**AC/DC Current Clamp** (CT233)

The CT233 AC/DC Current Clamp will allow the HD140B and 4410B to measure electrical current up to 600 amps (AC, DC or even AC on DC) without breaking the circuit being measured. Current levels sensed by this clamp are translated into a corresponding 1000:1mV output that is read by the meter using the AC or DC mV input ranges. This design is also unique in that the accuracy of the readings is not affected by the position of the current carrying circuit within the clamp jaws. A Zero Adjustment knob is also included to minimize the effect of stray magnetic fields, amplifier drift and hysteresis.

*CT233 AC/DC Current Clamp Specifications*

| | |
|---|---|
| Range (AC & DC): | 0 to 600A |
| Frequency Range (AC): | 30 to 400Hz |
| Accuracy (DC): | ±(2% reading +1A) |
| Division Ratio: | 1000:1 |
| Circuit-to-Ground Voltage: | ≤2000VRMS for one min. |
| Maximum Conductor Size: | 1.77 inches (45mm) |

| | |
|---|---|
| Accuracy (AC ≤ 65HZ): | 0-100A ±(2% rdg + 0.5A) |
| | 100-600A ±(2% rdg + 1A) |
| (AC > 65HZ): | 0-100A ±(3% rdg +0.5A) |
| | 100-300A ±(3% reading + 1A) |
| | 300-400A ±(4% reading + 1A) |
| | 400-600A ±(6% reading) |

**AC Current Clamp** (CT234A)

The CT234A AC Current Clamp extends the AC current measurement capability of any 4-½ Digit, True RMS Series Multimeter to 400A without breaking the circuit under test. The 1000:1 current transformer allows direct reading in amperes when used with the 200mA AC current range of the multimeter.

*CT234A AC Current Clamp Specifications*

| | |
|---|---|
| Range: | 4 to 400A RMS AC |
| Frequency Range: | 40Hz to 1kHz |
| Accuracy: | ±3.5% rdg ±0.4A |
| Division Ratio: | 1000:1 |
| Circuit-to-Ground Voltage: | ≤660 VRMS |
| Maximum Conductor Size: | 1.375 inches (34.9mm) diameter or 1.375 inches (34.9mm) x 2.5 inches (63.5mm) rectangle |

*Operation with CT234A AC Current Clamp*

The CT234A AC Current Clamp is connected to the A and COM Input Connectors of the multimeter in place of the TL245 Probe Set leads. The jaws of the current clamp are placed around one of the current carrying conductors. With the multimeter in the 200mA ACA position, current is read directly in amperes.

**Heavy Duty, Insulated Alligator Clips** (TL246B)

Two each (one red, one black). One piece silicone wire and heavy duty alligator clip. Meter end of each lead wire is terminated with a retractable sheath banana plug. Fits all 300 Series, HD Series, 200 Series, 800/850, 3000 Series and Tech Series multimeters, as well as the RMS225, HD160 and HD153 and 4 -½ Digit, True RMS Series Multimeters.

**Surface Mount Tweezer Probe** (TL247)

Tweezer clip with permanantly attached lead wires specifically designed for testing small Surface Mount Devices (SMDs) such as resistors and capacitors. Meter end of each lead wire is terminated with a retractable sheath banana plug. Fits all 300 Series, HD Series, 200 Series, 800/850, 3000 Series and Tech Series multimeters, as well as the RMS225, HD160 and HD153, and 4-½ Digit, True RMS Series Multimeters.

**Test Lead Accessory Kit** (DL243B)

Basic test lead kit. Includes solder-resistant, silicone lead wires, and several types of interchangeable probe tips (standard probe tips, insulated alligator clips and spade lugs). Meter end of each lead wire is terminated with a retractable sheath banana plug. Comes with durable cordura carrying case. Fits all 300 Series, HD Series, 200 Series, 800/850, 3000 Series and Tech Series multimeters, as well as the RMS225, HD160 and HD153, and 4-½ Digit, True RMS Series Multimeters.

**Deluxe Test Lead Accessory Kit** (DL248B)

Same as DL243B with the addition of two crimp-style spring hooks and a 2", needle-sharp probe tip extender that fits over the tip of standard probes. Comes with durable cordura carrying case. Fits all 300 Series, HD Series, 200 Series, 800/850, 3000 Series and Tech Series multimeters, as well as the RMS225, HD160 and HD153, and 4-½ Digit, True RMS Series Multimeters.

**SMD Deluxe Test Lead Kit** (DL249)

Special test lead kit designed to ease testing of SMD circuits. Contains silicone lead wires ( one red, one black) with retractable sheath banana plugs at meter end, standard probes (one red, one black), alligator clip (one black), SMD tweezer probes, crimp-style spring hooks (one red, one black), a 2" probe tip extender, a 16-pin SOIC clip and a 28-pin SOIC clip. Comes with durable cordura carrying case. Fits all 300 Series, HD Series, 200 Series, 800/850, 3000 Series and Tech Series multimeters, as well as the RMS225, HD160 and HD153, and 4-½ Digit, True RMS Series Multimeters.

**Individual Test Lead Replacement Parts**

| | |
|---|---|
| Silicone lead wires for DL243B, DL248B and DL249 (one red, one black) | (TL901) |
| Standard probe tips for DL243B, DL248B and DL249 (one red, one black) | (TL902) |
| Spring hooks for DL243B, DL248B and DL249 (one red, one black) | (TL903) |

2" needle tip extender for DL243B, DL248B and DL249 (one red, one black) (TL904)

Standard alligator clips for DL243B, DL248B and DL249 (one red, one black) (TL905)

Spade lugs for DL243B, DL248B and DL249 (TL906)

**Temperature/Voltage Converter** (TC253)

The TC253 converts Type K thermocouple voltages for use with any 4-½ Digit, True RMS Series DMM. It interfaces between the DMM and any Type K thermocouple or probe using a standard Type K miniature or subminiature connector. The display is switch-selectable to read in degrees C or F.

*TC253 Temperature/Voltage Converter Specifications*

Accuracy: *22°C ±3°C Ambient

| TEMPERATURE RANGE | | ACCURACY |
|---|---|---|
| °C | °F | |
| -50° to -10° | -58° to +14° | 1.2% rdg. +2.5°C or 4.5°F |
| -10° to +200° | +14° to +392° | 0.5% rdg. +1.5°C or 2.7°F |
| +200° to +500° | +392° to +932° | 0.7% rdg. +1.5°C or 2.7°F |
| +500° to +900° | +932° to +1652° | 1.4% rdg. +1.5°C or 2.7°F |

*For total measurement accuracy, include error due to meter and thermocouple.

*Operation with TC253 Temperature/Voltage Converter*

1. Plug TC253 into V-Ω and COM inputs of multimeter.
2. Plug in Type K thermocouple connecter at input, switch to °C or °F . Type K Thermocouple accessories, T254 (probe with four foot lead) and TP255 (four foot leads) are available for use with this accessory.
3. Select 200mVDC range (if "1," select 2VDC range) and read display in degrees.

**Fuse Pack** (FP260)

Each pack contains four 2A/600V fuses for the 4-½ Digit, True RMS Series Digital Multimeters.

This section describes maintenance procedures, calibration, and troubleshooting. In addition, a general statement on service policy is included. Any questions regarding warranty repair or instrument servicing should be directed to Wavetek Corporation or to a Service Center (see page 49 for addresses).

## Troubleshooting

Except for the replacement of the battery or fuse, repair of the multimeter should be performed only by a Factory Authorized Service Center or by other qualified instrument service personnel.

> **"P" The many components are subject to damage created by electrostatic discharge. Component should be handled only by qualified personnel equipped with antistatic grounding devices.**

If the multimeter is not performing properly, take the following steps before returning it for repair.

1. Check the battery and fuse connections.
2. Check to ensure that the Function/Range Switch is in the correct position for the parameter and value range being measured, and that the measurement value is within the capability of the instrument.
3. Review and comply with the operating instructions contained in Section IV of this manual.
4. Check test leads for breaks or cracks. Ensure that test leads are inserted fully into the connectors.
5. Check to see that the ambient environment in which the instrument is being used is within specifications given in Section V of this instruction manual.
6. If "BT" is displayed on the LCD, the battery is probably low. Replace the battery, using procedure on page 43 (HD140B) or page 45 (4410B).

7. If the Digital Display is blank with the unit turned on, the battery is probably dead. Replace the battery, using procedure on page 43 (HD140B) or page 45 (4410B).
8. If operation is normal in all functions and ranges except AC and DC current, the fuse is probably blown. Replace fuse, using procedure on page 44 (HD140B) or page 46 (4410B).

If the preceding steps do not remedy the problem, refer to the following pages for WARRANTY REPLACEMENT and NON-WARRANTY REPAIRS.

## Factory Service

The warranty statement for the 4- ½ DIGIT, True RMS Series Multimeters appears at the front of this manual. Read it carefully before requesting warranty repairs. Any 4-½ Digit, True RMS Series multimeter claimed to be defective should be returned to Wavetek Corp. Follow the instructions below and in Section VIII.

## Non-warranty Repairs

Any out-of-warranty meter that is defective, but repairable, can be repaired by an Authorized Service Center or by Wavetek Corp. (See Section VIII, page 49.) The repaired unit carries a six (6) month warranty. Contact any Authorized Service Center for their current non-warranty repair rates. The standard charge for repair at the Factory Service Center is $69.00.* Be sure to include (a) the specified payment or (b) a purchase order specifically authorizing repair and indicating the correct fee or the Multimeter will be returned to sender C.O.D.

## Shipping Instructions

Instruments returned for calibration or repair should be shipped with the following information or items: company name, your name, address, telephone number, proof of purchase (for warranty repairs), a description of the problem encountered or service required, and the appropriate service charge. Please include any test leads you have been using with the meter.

* Prices subject to change without notice.

Service charges should be remitted in the form of a check, money order or purchase order made payable to Wavetek Corp.

The multimeter should be shipped with transportation charges prepaid to the appropriate address in Section VIII (see page 49).

The multimeter will be returned with transportation charges paid by Wavetek Corp.

## Maintenance Procedures

Regular operator maintenance of the Multimeters consists of: cleaning case and window, battery replacement, and fuse replacement. All other repairs should be performed by a Factory Authorized Service Center or other qualified instrument service personnel.

### Cleaning Case and Window

**"P" Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. These chemicals will react with plastics used in construction of the case.**

The case is made of advanced generation plastic which resists damage from many chemical solvents including gasoline. However, the front panel and case should be cleaned with a mild solution of detergent and water. Apply sparingly with a soft cloth and allow to dry completely before using.

### Battery Replacement (Model HD140B)

**"W" To prevent electrical shock hazard, turn off multimeter and disconnect test leads before removing back cover.**

1. After disconnecting test leads and turning off multimeter, remove back cover by removing four screws, then lift off back cover.

**"P" Failure to turn off the instrument before installing the battery could result in damage to the battery if it is connected to the battery terminal incorrectly.**

2. The battery is located in the front part of the case. See Figure 11 below. Disconnect battery from instrument and replace with a standard 9V transistor battery.
3. Replace back cover and secure with four screws, taking care to seat O-ring seal uniformly.

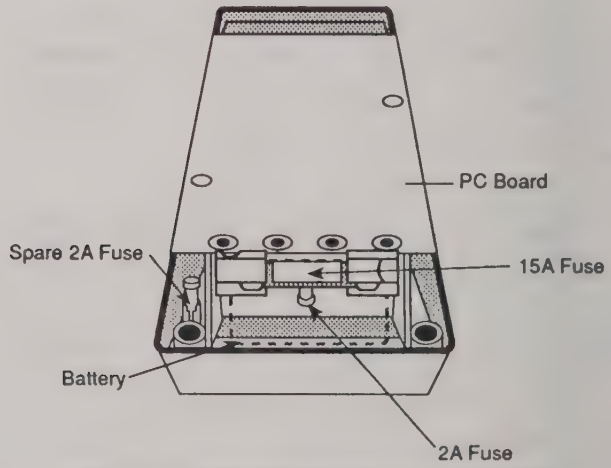



*Figure 11. Battery and Fuse Replacement HD140B*

**Fuse Replacement** (Model HD140B)

**"W" To prevent electrical shock hazard, turn off Multimeter and disconnect test leads before removing back cover.**

1. After disconnecting test leads and turning off the multimeter, remove back cover by removing four screws and then lifting off back cover.
2. The 2A fuse is located next to the battery, between the A and COM input jacks. Remove the fuse by pulling the ribbon. See Figure 11 on previous page.
3. Replace center of ribbon across the fuse opening and press new fuse into place. Be sure ribbon is between fuse clips, *not* caught on the clips.

**"W" To prevent fire, use Type 2A/600V and Type KTK or KLK 15A/600V fuses only. The 10A fuse clips must be insulated from battery. Check condition of battery-fuse insulator and replace if damaged.**

4. Replace back cover and secure with four screws.

**"W" Do not operate Multimeter with back cover removed (except during calibration).**

**Battery Replacement** (Model 4410B)

**"W" To prevent electrical shock hazard, turn off Multimeter and disconnect test leads before removing back cover.**

1. Remove two screws from battery cover.
2. Remove battery cover by pushing up and, then, pulling it out.

**"P" Failure to turn off the instrument before installing the battery could result in damage to the battery if it is connected to the battery terminal incorrectly.**

3. Lift battery from compartment.
4. Unsnap battery connector from battery and remove battery. See Figure 12 on the following page.
5. Snap battery connector onto new battery.
6. Insert battery into compartment.

7. Replace battery cover by pushing it forward and down.
8. Replace battery cover screws.

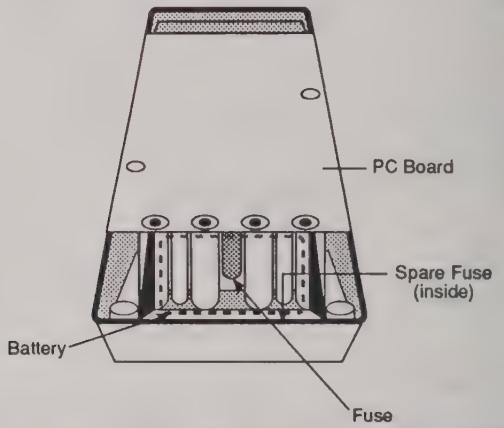



*Figure 12. Battery and Fuse Replacement Model 4410B*

**Fuse Replacement** (Model 4410B)

**"W" To prevent electrical shock hazard, turn off Multimeter and disconnect test leads before removing back cover.**

1. Remove two screws from battery cover.
2. Remove battery cover by pushing up and, then, pulling it out.
3. Lift battery from compartment.
4. Grasp loose end of ribbon. Hold multimeter and pull the ribbon to release the fuse.
5. Remove old fuse.
6. Turn multimeter over to allow spare fuse to drop out.

7. Replace center of ribbon across fuse opening and press new fuse into place. Be sure the ribbon is between the fuse clips, not caught on the clips.

**"W" To prevent fire, use Type 2A/600V Wavetek P/N FP260 and Type KTK or KLK15A/600V fuses only.**

8. Insert battery into compartment.

**"W" Do not operate Multimeter with battery cover removed (except during calibration).**

9. Replace battery cover by pushing it forward and down.
10. Replace battery cover screws.

## Factory Service

Read the warranty located at the front of this manual before requesting warranty or non-warranty repairs.

## Shipping Instructions

For in- and out-of-warranty repairs in the United States, we recommend shipping your multimeter to the factory for repair. Our factory service center features 24-hour turnaround time under normal circumstances, with a maximum of 48 hours guaranteed. Combined with low flat rate charges and fast turnaround time, the factory service center provides your best overall service alternative. (If you wish to utilize a local service facility, a list of authorized service centers in the United States can be found on the following pages.) A multimeter returned for calibration or repair should be shipped with the following: your company name (if applicable), your name, address, telephone number, proof of purchase (for warranty repairs), and any test leads used with the meter. In addition, make sure to **include a written description of the problem encountered or service required. For minimum turn-around time on out-of-warranty repairs please phone in advance for service-charge rates. Ship the multimeter with test leads in a sturdy box to the following address and marked *Attention: Instrument Repair/Service*:**

**For U.S.A.:**
Wavetek Corporation
9045 Balboa Ave.
San Diego, CA 92123
Tel: (619) 279-2200 ext. 670
800-223-9885
Fax: (619) 495-3296

**For U.K.:**
Wavetek Ltd.
Hurricane Way
Norwich, NR6 6JB, U.K.
Tel: 011-44-603-404824
Fax: 011-44-603-483670

**For Canada:**
(Refer to Service Centers-Canada on the following pages.)

The multimeter will be returned with the shipping charge paid by Wavetek Corp. For questions in North America, contact the Instrument Repair & Service Department at (619) 279-2200 ext. 670.

### Service and Shipping Instructions for Other Countries

Contact your local Wavetek Corp. dealer or distributor where the multimeter was purchased or refer to the *Service Centers - Other* list on the following pages.

See previous page for factory service center address. If local service is necessary, the following centers are authorized to repair Wavetek Corp. Instruments.

## Service Centers – U.S.A.

### Alabama

Arnolds Instrumentation
3258 Spring Hill Road
Mobile, AL 36607
(205) 478-3230

### California

Wavetek
Instruments Division
9045 Balboa Ave.
San Diego, CA 92123
(619) 279-2200 Ext 670
800-223-9885
Fax: (619) 565-7942

Standard Meter Labs
236 Rickenbacher Circle
Livermore, CA 94550
(415) 449-0220

### Colorado

Instrument Repair Labs
2100 W. 6th Avenue #A
Broomfield, CO 80020
(303) 469-5375

R&R Instruments
15701 E. 1st Ave., Unit 106
Aurora, CO 80011
(303)364-8325

### Georgia

Peach State Instruments
869-1 Pickens Industrial Drive
Marietta, GA 30062
(404) 424-0447

### Illinois

Metermaster, Inc.
2055 Army Trail Rd., Suite 134
Addison, IL 60101
(708) 268-8100

### Indiana

Electro Lab Services
1302 N. Fulton Avenue
Evansville, IN 47712
(812) 423-5211

### Louisiana

Industrial Instrument Works
5745 Salmen Avenue
Harahan, LA 70123
(504) 733-8355

### Maryland

EIL Instruments
10 Loveton Circle
Sparks, MD 21152
(301) 771-4800

### Massachusetts

Cal-Tek
20 Republic Road
N. Billerica, MA 01862
(508) 667-8541

EIL Instruments
21 'A' Street
Burlington, MA 01803
(617) 272-9450

### Minnesota

Instrumentation Services
957 Winnetka Avenue North
Minneapolis, MN 55427
(612) 544-8916

### Missouri

Industrial Service Labs
1530 Page Industrial Blvd.
St. Louis, MO 63132
(314) 423-3141

### New York

EIC Electronics
85 Avenue East
Rochester, NY 14621
(716) 544-4392

EIL Instruments
9020 Wehrle Drive
Clarence, NY 14031
(716) 634-8500

Instrument Mart
295 Community Drive
Great Neck, NY 11021
(516) 487-7430

### Oklahoma

Central Instrument Labs
3158 S. 108th E. Avenue
Tulsa, OK 74146
(918) 622-0114

### Ohio

Unitek
865 Cleveland Avenue
Columbus, OH 43201
(614) 291-9909

### Oregon

Westcon, Inc.
5101 N. Interstate Avenue
Portland, OR 97217
(503) 283-0132

### Pennsylvania

EIL Instruments, Inc.
701 Rodi Road
Pittsburgh, PA 15235
(412) 823-2255

Sunshine Instruments, Inc.
1810 Grant Avenue
Philadelphia, PA 19115
(215) 673-5600

### Texas

EIL Instruments
7385 Ashcroft Street
Houston, TX 77081
(713) 271-3100

Metermaster, Inc.
3405 Express Drive
Garland, TX 75041
(214) 271-5671

Meters & Instruments
6428 Gulf Freeway
Houston, TX 77023
(713) 644-1631

### Washington

EIL Instruments
2883 152nd Avenue NE
Redmond, WA 98052
(206) 882-3222

## Service Centers – Canada

### Alberta

Kingsway Aviation
4238 91 'A' Street
Edmonton T6E 5V2
(403) 463-5264

### British Columbia

Miller Instruments
3871 N. Fraser Way, Unit 1
Burnaby V5J 5G6
(604) 431-8882

### Manitoba

Probe Industrial Electronics
1874 Portage Avenue
Winnipeg R3J 0H2
(204) 885-9320

### Ontario

BCS Electronics
855 Matheson Blvd E, Unit 6
Mississauga L4W 4L6
(416) 602-8550

### Quebec

Projean Ltd.
1332 Rue Belanger East
Montreal H2G 1A1
(514) 273-8331

Primo Instruments
11235 Boul. L'Archeveque
Montreal-Nord H1H 3A8
(514) 329-3242

## Service Centers – Other

### Angola

Technidata Ltd.
P.O. Box 1619
Rua Reverendo Agostinho Pedro
Neto 21-21A
LUANDA
Tel: 32025/32309 Tlx: 3019

### Argentina

Reycom Electronica SRL
Uruguay 362 Peso 8-Depto. F
1015 BUENOS AIRES
Tel: 54-1-11-1722
Fax: 54-1-11-1721

### Australia

Bell-IRH Industries PTY
Warburton Franki Div.
32 Parramatta Road
LIDCOMBE, NSW2141
Tel: 61-02-648-5455
Fax: 61-02-647-1545

### Austria

LICO - GmbH
Felbigergasse 38
A-1140 WIEN
Tel: 0222-940621 Tlx: 133378
Fax: 0222-944174

### Bahrain

Al-Jishi Corporation
P.O. Box 617
Al-Khalifa Road
MANAMA
Tel: 253297 Tlx: 8371

**Belgium**
Mecotronic SA/NV
Nieuwelaan 58
1860 MEISE
Tel: 02-269 07 48 Tlx: 65602
Fax: 02-2699455

**Brazil**
Sistronics Instrumentacao E
Sistemas LTDA
Av Alfredo Agidio de Souza Aranha
75-4 Andares
Jd. Santo Antonio
CEP 04726 Sao Paulo, SP

**East Europe**
Technology International
20 Haymarket Terrace
EDINBURGH EH12 5JZ
SCOTLAND, UK
Tel: 031-3467050 Tlx: 727563
Fax: 031-3467065

**Denmark**
Instrutek-Periferi AS
Christianholmsgade
DK 8700 HORSENS
Denmark
Tel: +45-75-61-11-00
Fax: +45-75-61-56-58

**Egypt**
Etico Scientific
3 Ahmed Heshmat Street
P.O. Box 1653
Zamalek
CAIRO
Tel: 403041/407733 Tlx: 93382

**Finland**
Dualtek OY
P.O. Box 63
SFO2201 ESPOO
Tel: 358-0-452621
Fax: 358-0-45262261

**France**
BI-Wavetek SARL
IBis Ave du Coteau
93220 GAGNY
Tel: (01) 43027606 Tlx: 212971
Fax: (01) 43817252

**Germany**
Wavetek GmbH
Freisinger Strasse 34
D-8045 ISMANING
Tel: (089) 9609490
Fax: (089) 967170

**Greece**
Micronics Ltd.
46 Kritis Street
16451 Argyrouspolis, ATHENS
Tel: 301-9914786 Tlx: 216574
Fax: 301-9951814

**Iran**
Zeefax Ltd., Zeefax House
320 King Street
LONDON W6 ORR
Tel: 441-7487808 Tlx: 8813278
Fax: 441-7487188

**Ireland**
Neltronics Ltd.
John F. Kennedy Road
Naas Road
DUBLIN 12
Tel: 503560 Tlx: 24837
Fax: 552789

**Israel**

Appletec Ltd
2 Hamsager St., Beit Tiran
Unit 210
Ra'anana 43653
Tel: 972-52987350
Fax: 972-52443523

**Italy**

Beckman Industrial Componenti Srl
Via Arese 11
20159 MILANO
Tel: 392-6888951, Tlx: 330484
Fax: 392-6896995

**Jordan**

Scientific & Medical
Supplies Co. P.O. Box 1387
AMMAN
Tel: 962-6-24902, Tlx: 21456
Fax: 962-6-628258

**Kuwait**

AZ Trading Co.
P.O. Box 25752
Jaber Al-Mubarak Street
SAFAT
Tel: 965-2-442208, Tlx: 22707

**Lebanon**

Elco Ltd.
P.O. Box 136
ANTELIAS
Tel: 961-894420, Tlx: 22867

**Malta**

Fabian Enterprises
20, Msida Road
GZIRA
Tel: 356-513283, Tlx: 1837

**Mexico**

Dicopel SA
Francisco Pimentel 98
Col San Rafael
Delagacion Cuautemol
06470 MEXICO D.F.
Tel: 5-705-74-22
Fax: 5-703-17-72

Dinamica Inst. SA de CV
San Diego #25 Fracc Capistrano
54500 Aticapan de Zaragoza
Edo de MEXICO
Tel: 5-361-39-12
Fax: 5-398-41-83

**Morocco**

Sicotel AS
Complexe Commercial Des Harbous
Tour C, 3éme Etage
Ave Des Forces
Armées Royales,
CASABLANCA 01
Tel: 010-212-312270
Tlx: 27604M
Fax: 010-212-316545

**Netherlands**

Air Parts International BV
Kalkovenweg 12
2401 LK ALPHEN
AAN DEN RIJN
Tel: +31-1720-43221
Fax: +31-1720-20651

**Norway**

Hellermann Haugerud A/S
Sandakerveien 110
0483 OSLO 4
Tel: 47-2-156012, Tlx: 18469
Fax: 47-2-156129

**Oman**
Photocentre Comcent
P.O. Box 3115 (Ruwi)
MUSCAT
Tel: 968-773948 Tlx: 3499

**Portugal**
Decada, Equipamentos Electronicos Lda
Miraflores, Lote 102-B Alges
LISBOA 1495
Tel: 351-1-4103420 Tlx: 15515
Fax: 351-1-4101844

**Qatar**
Qatar Trading Co.
P.O. Box 51
DOHA
Tel: 974-323773 Tlx: 328642
Fax: 974-328642

**Saudi Arabia**
Mejdaf Establishment
P.O. Box 2002
RIYADH 11451
Tel: 4013206/4055240
Fax: 4630048 Tlx: 202787

**South Africa**
Bowthorpe Hellermann Deutsch Ltd.
80 Mimetes Rd, Denver 2094
P.O. Box 27063, Benrose 2011
JOHANNESBURG
Tel: 11-6161960, Tlx: 4-28237
Fax: 11-6164715

**Spain**
ESSA Equipos y Sistermas SA
Apolonio Morales, 13-B
28036 MADRID
Tel: +34-1-3590088 Tlx: 42615
Fax: +34-1-3590298

**Sweden**
Q Instrument AB
P.O. Box 515, S-145
63 NORSBORG
Tel: 0753-86155
Fax: 0753-84414

**Switzerland**
Gould Elektronik AG
Einsiedelstrsse 535
810 HORGEN
Tel: +41-1-7260000
Fax: +41-1-7260788

**Syria**
Far-Tou Representation
Place de l'Etoile P.O. Box 2657
29 Rue Parlement
DAMASCUS
Tel: 963-11-222261
Tlx: 411319

**Tanzania**
International Services Ltd.
Makunganya Street
P.O. Box 5120
DAR ES SALAAM
Tel: 01-30778, Tlx: 41312

**Tunisia**
Tunisie Electronique Sarl
31 Avenue de la Liberté
1002 TUNIS - Belvedere
Tel: 01-280144, Tlx: 13238

**Turkey**
Turkelek Elektronik Co. Ltd.
Hatay Sokak 8
ANKARA
Tel: 189483, Tlx: 42120

**United Arab Emirates**

Scientechnic
P.O. Box 325
DUBAI
Tel: 971-4-4666000, Tlx: 46072
Fax: 971-4-4666176

**United Kingdom**

Wavetek Ltd.
Hurricane Way
NORWICH, NR6 6JB
Tel: 011-44-603-404824
Fax: 011-44-603-483670

**Venezuela**

ONIMEX CA
2 Av. entre 3 y 4 Calles #42-13
Quinta Onimex
LOS PALOS GRANDES
Tel: 2-285-86-41
Fax: 2-285-84-17

**Zimbabwe**

BAK Electrical Holdings Ltd.
30 Pioneer Street
HARARE
Tel: 707601, Tlx: 2343

MP MASTER
MA35755

**Wavetek**
**Instruments Division**
9045 Balboa Ave.
San Diego, CA 92123
Tel: (619) 279-2200
800-223-9885
Fax: (619) 565-7942